PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference DSC/P02124WO/JEC	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/GB2004/005424	International filing date *(day/month/year)* 23.12.2004	Priority date *(day/month/year)* 24.12.2003
International Patent Classification (IPC) or national classification and IPC B25B1/24, B21D37/02, B23Q3/06		
Applicant SURFACE GENERATION LTD. et al.		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 7 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 11 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☒	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☒	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
20.07.2005	07.02.2006
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Lasa, A Telephone No. +49 89 2399-2641

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/GB2004/005424

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

   Description, Pages

   1-15 as originally filed

   Claims, Numbers

   1-59 received on 25.10.2005 with letter of 20.10.2005

   Drawings, Sheets

   1/13-13/13 as originally filed

   ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application,

☒ claims Nos. 6-13, 19-36

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (specify):

☐ the description, claims or drawings *(indicate particular elements below)* or said claims Nos. are so unclear that no meaningful opinion could be formed *(specify)*:

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☒ no international search report has been established for the said claims Nos. 6-13, 19-36

☐ the nucleotide and/or amino acid sequence listing does not comply with the standard provided for in Annex C of the Administrative Instructions in that:

the written form	☐	has not been furnished
	☐	does not comply with the standard
the computer readable form	☐	has not been furnished
	☐	does not comply with the standard

☐ the tables related to the nucleotide and/or amino acid sequence listing, if in computer readable form only, do not comply with the technical requirements provided for in Annex C-*bis* of the Administrative Instructions.

☐ See separate sheet for further details

Box No. IV Lack of unity of invention

1. ☒ In response to the invitation to restrict or pay additional fees, the applicant has:
   - ☐ restricted the claims.
   - ☐ paid additional fees.
   - ☐ paid additional fees under protest.
   - ☒ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

   ☐ complied with.

   ☒ not complied with for the following reasons:

   see separate sheet

4. Consequently, this report has been established in respect of the following parts of the international application:

   ☐ all parts.

   ☒ the parts relating to claims Nos. 1-5,14-18,37-59 .

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	4-5,43-49,56
	No:	Claims	1-3,14-18,37-42,50-55,57-59
Inventive step (IS)	Yes:	Claims	43-49,56
	No:	Claims	1-5,14-18,37-42,50-55,57-59
Industrial applicability (IA)	Yes:	Claims	1-5,14-18,37-51
	No:	Claims	

2. Citations and explanations (Rule 70.7):

   see separate sheet

Re Item IV.

This Authority considers that there are four inventions covered by the claims indicated as follows:

1) Claims 1-5,14-18,37-59

Tooling system according to claim 2 with movable parallel supporting rails. Method of using such a tooling system.

Problem solved: provide means for moving the elements into an open position so that they are free to be adjusted vertically.

2) Claims 6-13

Tooling system according to claim 2 with means for engaging and holding the elements.

Problem solved: enable engagement of the elements for their positioning.

3) Claims 19-21

Tooling system according to claim 1 with different adjusting means.

Problem solved: provide alternative means for adjusting the position of the elements.

4) Claims 22-36

Tooling system according to claim 1 with special clamping means.

Problem solved: clamp selectively one or more elements of the array.

The reasons for which the inventions are not so linked as to form a single general inventive concept, as required by Rule 13.1 PCT, are as follows:

The common subject-matter of the 1st and 2nd invention is a tooling system according to claim 2. Such a system is not new because it is disclosed in WO-02/064308-A (see novelty analysis in point V.2) below). Thus, these two inventions are not linked by a single general inventive concept.

The common subject-matter of the 1st, 3rd and 4th invention is a tooling system according to claim 1. Such a system is not new because it is disclosed in WO-02/064308-A. Thus, these three inventions are not linked by a single general inventive concept either.

Re Item V.

1) Cited documents

D1: WO 02/064308 A

2) Novelty

The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1 is not new in the sense of Article 33(2) PCT.

Document D1 (see Fig. 4-5) discloses:
a **tooling system comprising:**
a plurality of elongated elements (18) **each having an upper surface, said elements being arranged in an array** (28) **to present said upper surfaces for machining by cutting tool means** (62);
support means (66) **for supporting said elements, each said element being supported on said support means for axial movement between upper and lower positions relative to the other elements in the array thereby to enable adjustment of the vertical position of said element surface;**
and clamping means (24, 26) **for clamping the array of elements in a closed position in which the elements contact one another for enabling the free ends of the elements to be machined to produce a desired surface contour** (22).
Furthermore, the tooling system of D1 comprises "means to adjust the relative longitudinal positions of the elements such that the free ends of the elements define approximately a desired surface contour", and "the elements may be machinable to an exact surface contour" and "may be reused a number of times, being machined with a new surface contour as desired for a particular tool".
Thus, the tooling system of D1 necessarily comprises **means for storing existing data representing the contour of the surface of each element, means for storing new data representing a desired contour for the surface of each element in the array; means for comparing said new data with the existing data, and means for adjusting the height of an element to values at least equal to values of said new data,** according to the present claim 1.

D1 describes as well the combinations of features of claims 2-3 and 14-18, so that the tooling systems of these claims are not new.

The tooling system known from D1 works according to the method of claims 37-42, 50-55 (as dependent on claim 37) and 57-59, so that these methods are not new.

3) Inventive step

Dependent claims 4-5 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step.

4) Other remarks

The methods of claims 43-49 and 56 are new and inventive. D1 or any other document of the prior art doesn't describe such a method of using a tooling system of claim 1, for adjusting the position of an element of the array.

CLAIMS

1 A tooling system comprising:

a plurality of elongate elements each having an upper surface, said elements being arranged in an array to present said upper surfaces for machining by cutting tool means;

support means for supporting said elements, each said element being supported on said support means for axial movement between upper and lower positions relative to the other elements in the array thereby to enable adjustment of the vertical position of said element surface;

and clamping means for clamping the array of elements in a closed position in which the elements contact one another for enabling the free ends of the elements to be machined to produce a desired surface contour and furtehr comprising means for storing existing data representing the contour of the surface of each element including the z values of the surface at any given x,y coordinate point relative to a datum; storing new data representing a desired contour for the surface of each element position in the array including the z values of the surface at said any given x,y coordinate point relative to said datum; comparing said new data for a first, selected element position with the existing data for a first element in said selected element position; and adjusting the height of said first element to adjust said z values of said existing data at said any given x,y coordinate point to values at least equal to said z values of said new data at said any given x,y coordinate point.

2 A tooling system as claimed in claim 1 further comprising:

drive means for moving the elements of the array between said closed position in which the elements contact one another, and an open position in which at least one selected element is spaced from adjacent elements for enabling axial adjustment of said selected element;

and adjustment means for adjusting the axial position of each element such that the upper surfaces of the elements define approximately said desired surface contour.

3 A tooling system as claimed in claim 1 or 2 wherein:

said support means comprises a plurality of supporting rails arranged parallel with one another;

each said support rail supports a plurality of elements;

and said support rails are movable laterally relative to one another.

4 A tooling system as claimed in claim 3 wherein said drive means includes means for gripping said support rail.

5 A tooling system as claimed in claim 4 wherein each said rail has locating means at each end thereof engageable by said gripping means.

6 A tooling system as claimed in any of claims 2 to 5 wherein said adjustment means comprises means for engaging and holding an element thereby to enable adjustment of the element position by said adjustment means.

7 A tooling system as claimed in any of claims 2 to 6 wherein said adjustment means comprises a fork having a head portion, and a plurality of spaced tines depending from the head portion for engaging an element, the tines defining an adjustment area corresponding to the area of an element of the array.

8 A tooling system as claimed in claim 7 wherein the fork comprises a substantially square head portion and a respective tine depending from each corner of said head portion, the tines defining an adjustment area corresponding to the area of an element of the array.

9 A tooling system as claimed in claim 7 or 8 wherein the position of the tines is adjustable relative to one another to accommodate a plurality of differently sized elements.

10 A tooling system as claimed in claim 7, 8 or 9 wherein each tine comprises:

a first section adjacent to the head portion and having an inwardly facing surface which together with the inwardly facing surfaces of the other tines defines an adjustment area;

and a second section remote from the head portion and having an inwardly facing guide surface.

11 A tooling system as claimed in claim 10 wherein the inwardly facing guide surface of the second section of the tine is convex.

12 A tooling system as claimed in 10 or 11 wherein said first section of each tine is substantially triangular in cross-section, leading to said second section, the inwardly facing surface of which tapers towards the free end of the tine.

13 A tooling system as claimed in 12 wherein the square head portion is adjustable in size, so that the tines can be moved relative to one another to define a plurality of differently sized adjustment areas, corresponding to differently sized elements.

14 A tooling system as claimed in any of claims 2 to 13 further comprising:

a tool holder for receiving said cutting tool means, said tool holder being supported for movement in orthogonal x, y, z directions wherein x and y represent orthogonal axes in a horizontal plane and z represents the vertical axis;

and drive means for moving said tool holder in said orthogonal directions.

15 A tooling system as claimed in any of claims 1 to 14 wherein:

each said element has a plurality of sides arranged such that in said closed position of said array each side abuts a side of an adjacent element;

said elements are supported on said support means in rows;

said support means is adjustable to enable a selected element to be spaced from adjacent elements thereby to enable said axial adjustment of the selected element.

16 A tooling system as claimed in claim 15 wherein:

each said element is substantially square in cross section;

said elements are formed in a diamond array and are supported on said support means in rows in which the elements of a row are aligned along a diagonal of each element;

said support means is arranged to enable each row of elements to be moved laterally relative to each adjacent row;

and each element is supported on said support means for rotation about its longitudinal axis thereby to enable said axial adjustment of the element.

17 A tooling system as claimed in any of claims 1 to 16 in which the elements are constructed from an upper portion, and a lower portion, the upper portion being removable and machinable.

18 A tooling system as claimed in any of claims 1 to 17 in which in a closed position said array presents a continuous upper surface.

19 A tooling system as claimed in any of claims 1 to 18 wherein each said element is supported on said support means such that the height of said element is adjustable in a screw-threaded manner.

20 A tooling system as claimed in claim 19 wherein each said element is supported on said support means by a screw threaded axial rod engaged in a screw threaded bore in said support means.

21 A tooling system as claimed in any of claims 1 to 19 wherein each said element is

supported on said support means by electric or electromagnetic means, hydraulic or pneumatic ram means for adjusting the height of said element.

22 A tooling system as claimed in any of claims 1 to 18 wherein said clamping means has an element contacting face which is adapted selectively to apply localised pressure to one or more elements of the array.

23 A tooling system according to any of claims 1 to 22 wherein the elements of the array are substantially polygonal in cross section.

24 A tooling system as claimed in claim 23 wherein the array is substantially triangular, rectangular or pentagonal in plan view and clamping means are provided on at least two adjacent sides of the array.

25 A tooling system as claimed in claim 23 or 24 wherein the elements of the array are arranged so that, in the closed position of the array, the major axes of adjacent elements are aligned and their vertices touch one another, so that the elements of the array tessellate.

26 A tooling system as claimed in claim 24 or 25 wherein said array is substantially rectangular in plan view and clamping means are provided on at least two adjacent sides of the rectangular array.

27 A tooling system as claimed in claim 26 wherein clamping means are provided on all four sides of the rectangular array.

28 A tooling system as claimed in claim 26 or 27 wherein the outer edges of the rectangular array are serrated and the clamping means has a correspondingly serrated face.

29 A tooling system as claimed in any of claims 1 to 28 wherein the face of the clamping means contacting the array is formed from a plurality of teeth, at least some of which teeth are adjustable in order selectively to apply localised pressure to one or more elements of the array, in line with the sides of the elements.

30 A tooling system as claimed in claim 29 wherein the teeth are also individually adjustable in height relative to one another.

31 A tooling system as claimed in any of claims 1 to 30 wherein the clamping means comprise two sets of clamps, the first of which is used during machining of the elements of the tooling system and the second of which is used when the elements of the array have been machined and the system is being used as a mould.

32 A tooling system as claimed in any of claims 1 to 31 wherein the clamping means are modular in design, so that individual clamping sides interlock with one another to form larger units.

33 A tooling system as claimed in any of claims 1 to 32 further comprising vibrating means for vibrating the clamp sides to assist in bedding down the elements of the array.

34 A tooling system as claimed in any of claims 1 to 33 further comprising sensors for detecting and measuring the forces applied to the elements of the array.

35 A tooling system as claimed in any of claims 1 to 34 further comprising means for securing the clamping means in position around the array of elements.

36 A tooling system as claimed in any of claims 1 to 35 wherein said clamping means are adjustable in height relative to the height of said elements.

37 A method of tooling using a tooling system as claimed in any of claims 1 to 36 comprising:

storing existing data representing the contour of the surface of each element including the z values of the surface at any given x,y coordinate point relative to a datum;

storing new data representing a desired contour for the surface of each element position in the array including the z values of the surface at said any given x,y coordinate

point relative to said datum;

comparing said new data for a first, selected element position with the existing data for a first element in said selected element position;

and adjusting the height of said first element to adjust said z values of said existing data at said any given x,y coordinate point to values at least equal to said z values of said new data at said any given x,y coordinate point.

38 A method as claimed in claim 37 further comprising repeating the steps of comparing said data and adjusting the height of the element for each element position and element in said array.

39 A method as claimed in claim 37 or 38 wherein said data includes the gradient and rate of change of curvature of the surface.

40 A method as claimed in any of claims 37 to 39 further comprising providing a preselected height adjustment offset for said elements in said array.

41 A method as claimed in any of claims 37 to 40 further comprising:

supporting said elements for axial movement between upper and lower positions relative to the other elements in the array thereby to enable adjustment of the vertical position of said element surface;

and clamping the array of elements in a closed position in which the elements contact one another for enabling the free ends of the elements to be machined to produce said desired surface contour.

42 A method as claimed in claim 41 further comprising moving the elements of the array between said closed position in which the elements contact one another, and an open position in which at least one selected element is spaced from adjacent elements for enabling axial

adjustment of said selected element;

gripping said support rail by engaging said gripping means with said locating means

and adjusting the axial position of each element such that the upper surfaces of the elements define approximately said desired surface contour.

43 A method as claimed in any of claims 37 to 42 further comprising engaging and holding an element thereby to enable adjustment of the element position.

44 A method as claimed in claim 42 wherein each said element has a plurality of sides arranged such that in said closed position of said array each side abuts a side of an adjacent element;

and the step of adjusting the height of a selected element comprises adjusting the position of adjacent elements to space said adjacent elements laterally from said selected element thereby to allow movement of said selected element.

45 A method as claimed in claim 44 wherein said elements are arranged in rows in said array and the step of adjusting the height of a selected element includes laterally separating the row containing the selected element from the next adjacent rows.

46 A method as claimed in claim 45 wherein the step of laterally separating the row containing the selected element from the next adjacent rows comprises:

determining the position of the row within the rows in the array;

and where the number of rows to be moved exceeds a preset value, moving a smaller number of rows in turn until said selected row is moved.

47 A method as claimed in claim 45 or 46 wherein each said element is shaped in cross section such that rotation of an element relative to adjacent elements in a row spaces said

element from said adjacent elements.

48 A method as claimed in claim 47 wherein spacing each said element from an adjacent element in a row comprises rotating each said element through a preselected angle.

49 A method as claimed in claim 48 wherein said preselected angle is 45 degrees.

50 A method as claimed in any of claims 37 to 49 wherein each said element is rotatably supported and the height of said element is adjusted by rotation of said element.

51 A method as claimed in claim 50 wherein the step of adjusting the height of said element comprises comparing said existing data for the element with new data for the element position and rotating said element through a preselected angle to rotate the surface of the element into a position where the existing data approximates closest to said new data.

52 A method as claimed in claim 51 wherein said preselected angle is one of 90°, 270° and 180°.

53 A method as claimed in any of claims 37 to 52 wherein

each said element is substantially square in cross section;

and said elements are formed in a diamond array and are supported in rows in which the elements of a row are aligned along a diagonal of each element.

54 A method as claimed in any of claims 37 to 53 further comprising storing further data representing the new surface contour of the adjusted elements prior to machining.

55 A method as claimed in claim 54 further comprising machining the surface of the elements of the array after adjustment in dependence on the difference between the desired surface contour and the actual surface contour.

56 A method as claimed in claim 55 further comprising comparing the amount of material to be machined from an element with a reference value and replacing said element with a plurality of smaller elements in dependence thereon;

and adjusting the height of each said smaller element to adjust z values of existing data for said smaller elements to values at least equal to z values of said new data for said smaller element positions.

57 A method of tooling using a tooling system as claimed in any of claims 1 to 36 comprising:

storing existing data representing the existing contour of the surface of each element of at least one existing array including the z values of the surface at any given x,y coordinate point relative to a datum;

storing new data representing a desired contour for the surface of each element position in a new array including the z values of the surface at said any given x,y coordinate point relative to said datum;

comparing said new data for a first, selected element position with the existing data for at least a first element in the or each said existing array;

and in dependence on said comparison:

(i) where the existing surface of one of said existing arrays approximates closest to said desired surface, selecting said existing array for machining and adjusting the height of each element of said existing array to adjust said z values of said existing data to values at least equal to said z values of said new data;

(ii) where the existing contour of the surface of an existing element of at least one existing array approximates closest to said desired surface, selecting said existing element and moving said existing element to said selected element position in said new array for

machining, and adjusting the height of said existing element to adjust said z values of said existing data to values at least equal to said z values of said new data;

(iii) where the existing surface of an existing element at said first, selected element position approximates closest to said desired surface, adjusting the height of said existing element to adjust said z values of said existing data to values at least equal to said z values of said new data.

58. A method as claimed in any of claims 37 to 57 further comprising the step of aligning the elements within the array relative to each other after they have been adjusted in the z plane so that, when closed, the array has no gaps within it.

59. A method as claimed in claim 58 in which the elements are aligned automatically.